Bull. Spec. Astrophys. Obs., 2005, 58, 118-129

Current status of the CATS database

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Received November 3, 2004; accepted .

Abstract. We describe the current status of CATS, a publicly accessible database (web-server http://cats.sao.ru) allowing one to search in hundreds of catalogs of astronomical objects discovered all along the electromagnetic spectrum. Our emphasis is mainly laid on catalogs of radio continuum sources observed from 30 to 15000 MHz, secondly on catalogs of objects such as radio and active stars, planetary nebulae, HII regions, supernova remnants (SNR), pulsars, nearby galaxies, AGN and quasars. CATS also includes the catalogs from the largest extragalactic surveys, like NVSS, FIRST, WENSS, VLSS, TXS, GB6, SUMSS, IRAS, 2MASS, SDSS, ROSAT, PGC, MCG, etc. In 2004 CATS comprised a total of $\sim 10^9$ records from over 400 catalogs in the radio, IR, optical and X-ray windows, including most of RATAN–600 catalogs. CATS is being expanded and updated, both with newly published catalogs as well as older ones which we have created in electronic form for the first time. We describe the principles of organization of the database of astrophysical catalogs and the main functions of CATS.

Key words: astronomical data bases: catalogs — radio astronomy: radio sources

Introduction

Vast amounts of astrophysical information are now being published, based on observations of small and large sky regions. Typically, this information includes coordinates of the observed objects and their physical characteristics in different wavelength ranges in the form of source catalogs. In fact, every new large–scale observational experiment produces a new catalog of objects. Modern astrophysics operates with source parameters obtained in different spectral wavelength ranges with the goal of obtaining the most detailed understanding of physical properties and the processes of radiation of these objects. The ability of using different catalogs makes this problem considerably simpler.

Over the past decades several different attempts have been made to combine large numbers of astronomical catalogs and make them accessible in a unified way, which can be classified grossly into two categories: databases of objects and catalog browsers. Examples of the former are NED (Helou et al. 1990; Mazzarella et al. 2002), Simbad (Egret 1983; Wenger et al. 2000) and LEDA (Paturel et al. 1997). Examples of the latter are Vizier (Ochsenbein et al. 2000) and AstroBrowser (http://heasarc.gsfc.nasa.gov/ab/).

Motivated by RATAN-600 observation requirements, problems of radio source study, and the underrepresentation of radio source catalogs in the then existing object databases, the present authors decided, in 1995, to create CATS, the *Astrophysical* **CAT***alogues* **S***upport System*. Following the radio astronomical needs, the architecture of operating system and the considerations expressed in the reviews by Andernach (1990, 1994, 1999), we chose to design CATS as a catalog browser rather than an object database, given that it would allow us to achieve a much better completeness in number of records, implying e.g. a more complete coverage of radio source measurements over the entire radio frequency window. We thus deliberately delayed the known problem of cross-identification of all the catalogues, as provided in NED, SIMBAD, or LEDA, to a later stage. In that sense CATS is ideally suited for the experienced researcher who is looking for the largest amount of data available, but willing and able to work out the correct cross-identifications by himself. His effort will be compensated for by a better completeness of the data than that obtained from other existing object databases.

The first steps of the creation of CATS were described by Verkhodanov & Trushkin (1994, 1995a,b), Verkhodanov et al. (1997, 2000a) and Trushkin et al. (2000). CATS allows one to operate with catalogs stored in ASCII and FITS Binary tables, to fit radio continuum spectra and to calculate spectral indices obtained from different radio catalogs. This database is located at the server *cats.sao.ru* under OS Linux

Fedora Core 2, Dual Opteron 244, at Special Astrophysical Observatory, Russia.

Implementation of the database

The present database consists of catalogs, their descriptions and corresponding programs operating under OS Unix. The program codes are created in the "C" algorithmic language and translated with the GNU project C compiler. The codes are freely shared, provided they are used for non–commercial goals. The scheme of the CATS database is shown in Fig. 1.

New catalogs may be added to the system in conformity with the following rules:

1) every new catalog of objects should be placed in the UNIX directory with the same name as the catalog of objects;

2) the description of the catalog should also be placed in that directory;

3) the programs (or operating scripts) for local operations with the catalog of objects are also placed in the same directory;

4) brief characteristics, program names and description file of the astrophysical catalog are stored in the database of descriptions of catalogs named *cats_descr*.

The following information is stored in the database of the catalog descriptions *cats_descr*: the name of the catalog, which is coincident with the name of the UNIX directory, the type of the catalog (radio, optical, combined, etc.), frequency/wavelength range, minimum fluxes or magnitudes, equatorial or/and galactic coordinates, names of the local programs for the "*select*" and "*match*" functions (see below corresponding Section), the name of the document file, the number of records in the catalog, the size of the beam pattern or angular resolution, a recalibration factor (if available) to put the flux densities on a commonly agreed flux scale, and a reference. Parameters from the description file are used by the programs that process the input data. E.g., user-specified limits in coordinates and/or flux density inform the operating programs about the relevant sky zones to be searched, and thus economize on processing time if a given catalog is out of the required range. Whenever a certain catalog column is empty for a given object, a symbol 'n' is returned to the output for the corresponding column, and considered as an 'empty' or 'unknown' value. This symbol is acceptable for the program operating with this database.

The lower level of the CATS control system includes several basic utilities:

- *c_sel* selects objects with parameters from the given ranges;
- *c_match* looks for objects falling within a certain coordinate error box;
- *cats_divide* operates with sorted catalogs by right ascension and produces an index of record numbers corresponding to a certain right ascension;
- *epoch* calculates equinox and epoch. The epoch is calculated when a given one is different from 1-Jan-2000 or 1-Jan-1950[1], else the equinox is calculated; The catalog is stored in initial equinox haw it was prepared, and object coordinates are calculated in to that equinox;
- *cats_base* controls the database of descriptions *cats_descr* and produces input parameters for the programs *c_sel* and *c_match*.

For catalogs in FITS Binary table format (e.g., NVSS or SDSS catalogs), special programs for the 'select' and 'match' functions were prepared.

To organize access of a local user of CATS from any directory of the OS, the operation programs that process the main CATS tasks are placed in a commonly accessible directory of the OS UNIX. The control procedures *cats_sel* and *cats_match*, organized as shell–scripts, cover all the low-level programs and provide the interface between CATS and a local user, or requests made via HTTP or e-mail. The described method of the catalog storage facilitates the database development, its expansion with new data and the possibility to tune the supporting programs.

CATS has its own indexing procedure *cats_divide* for object coordinates in a catalog. The program decides on where to start searching records of the input catalog from an index prepared from a right-ascension sorted list. It allows one to make efficient use of hard-disk seeking functions. To avoid the problems of searching within a few degrees at the poles when recalculation from one equinox to another one is done, we process total list of objects in these zones to find a required source. The indexing of CATS lists by declination is now under consideration.

The main functions

The following functions are currently implemented in CATS:

1. Selection of objects from one or several catalogs by the main parameters: equatorial or galactic coordinates, flux densities, spectral indices, frequencies, names, and (for some catalogs) the type of objects. Parameters common to all catalogs (coordinates and flux density) are used in selection.

2. Search for counterparts of objects (selected from one or several catalogs) by coordinate matching within the error box, circle, or ellipse.

[1] Proper motions are assumed to be zero

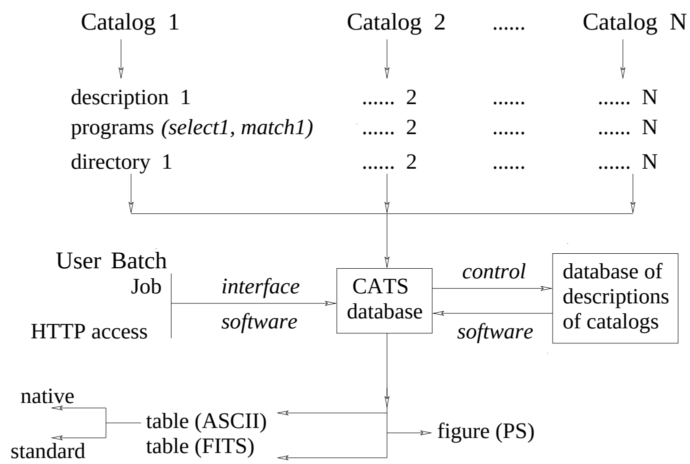

Figure 1: *This CATS scheme demonstrates the basic elements of the database structure: programs and descriptions unified in the corresponding directory. Information about the directories and programs is stored in the database of descriptions cats_descr. The database has exchange of information with the repository cats_descr. User requests of selection and matching can be processed in batch mode or via HTTP access. Output tables are prepared in the "native" or "standard" format (see text).*

3. Cross–identification of different catalogs. This procedure is currently available only for local users. It uses the output from the selected zones of one catalog as input for the matching procedure on another catalog.

4. Preparation of receipt with a short description and characteristics of each catalog, printing of the total list of catalogs for the required sky areas (for local user).

5. Drawing radio spectra of selected sources. This can be done from multi-frequency catalogs, or catalogs prepared by the CATS team from cross-identification of radio catalogs at different frequencies, or even by individual user input of frequencies and flux densities for a source (at cats.sao.ru/∼satr/SP/spectrum.html). This function is realized in two procedures. The first one is a Javascript for homogenized CATS data format for single objects accessible from the web page. The second one is in the local data processing system FADPS for object lists.

The result of the object selection is a datafile sorted according to different object characteristics (right ascension (default mode), declination or frequency). This file can either be displayed on the standard output or sent to the user in the following formats:

1. The "native" (original) format of the catalog (i.e. columns as published); for guidance of the user a header with a very brief column description is added for each catalog that yielded output records.

2. Standard ("homogenized") output format. This format is organized to be common for all the catalogs and used later for unification of data, preparation of spectra and statistical analysis. The standard FITS Table format describing data and fields of the table may be added as a header of the resulting file.

The result may then be used for subsequent investigation of the radio source spectra or statistical properties of objetcs in a flexible astronomical data proccessing system FADPS (Verkhodanov 1997) or, e.g. for the selection of distant objects in combination with redshift and age estimation with the system "Evolution of radio galaxies" (Verkhodanov et al. 2000b).

Access to CATS

Different modes of access are provided according to user requirements and CATS goals, following modern trends of software development. Thus, three main modes of on-line access to the CATS database have been prepared:

1. **Dialogue mode** (non-graphics) has been maintained until the present. Several scripts written in the UNIX *shell* language have been created (Verkhodanov & Trushkin 1994). They permit one to operate with the database supporting programs via TCP/IP and NFS protocols in the local computer network.

2. **Hypertext access** (http://cats.sao.ru) is provided to allow a user from the Internet system to operate with the database CATS via hypertext transfer protocol. It allows one to execute all described operations from the Web-page.

3. **ftp access** (ftp://cats.sao.ru) allows a user to obtain both the description of CATS catalogs and

the catalogs themselves. Here is an example of access by anonymous FTP to the catalog WISH:
anonymous@ftp://cats.sao.ru

```
ftp>  bin
ftp>  cd  WISH
ftp>  get wish11.cat
ftp>  bye
```

All the catalog names are stored in the file of descriptions *cats_descr* (ftp://cats.sao.ru/cats_descr).

4. **e-mail access** allows the user to send batch requests to CATS. One can send an e-mail with requests of matching with lists or selection by several parameters. The e-mail will be read automatically and sent for execution to the CATS scripts. The result will be sent back automatically to the user via e-mail.

'Select' and 'match' procedures

Two main procedures of data selection have been provided at different levels of the CATS control. They are the *select* and *match* tasks. They follow the first three main functions described above and are realized in different access modes. As was described earlier, the two low-level procedures *c_sel* and *c_match* provide information according to the corresponding user requests and pass it to the upper-level control scripts *cats_sel* and *cats_match*.

Using these two procedures the cross-identification of catalogs is possible by using the output from the 'select'–function of the first complete catalog as the input of the 'match'–function of the second catalog or catalogs.

E-mail access

In order to economize on the user's real time and avoid the delays in on-line data exchange, we provide a possibility to submit a batch task in the form of an e-mail letter.

The e-mail requests may have several formats (as explained in a file that is returned on an empty e-mail to cats@sao.ru, with no subject). Two examples of the body of an e-mail (no subject required) are shown below.

- selection task:

mail -s "" cats@sao.ru

```
cats select
ra min=10:30 max=10:40:00.
dec > 10' < 12' 30"
flux > 0.5mJy
catalogs r equinox=1950
cats end
```

- matching task:

mail -s "" cats@sao.ru

```
cats match
catalogs NVSS,FIRST
window box x=30" y=10'
sources:
s1 02:02:00    +31:23:16   1950
s2 02:23:10     34:03:00   1950
s3 21:26:33.9  -18:34:33.0 1950
cats end
```

These examples demonstrate the use of some keywords for batch requests (see the results of these requests in Tables 1 and 2). The beginning and the end of the request are defined by the statements: `cats start` and `cats end`. The first example shows how to search within certain limits of coordinates by using the (`min, max`) or (<, >) operators for right ascension (`ra`) and declination (`dec`). The keywords expression '`catalogs r`' sets the type of catalogs to be used for selection, where '`r`' means all the radio catalogs. Instead of '`r`', one may choose '`o`' for the optical catalogs, '`x`' for the X–ray ones, '`ir`' for the infrared ones, or just the names of used lists separated with comma (e.g. '`catalogs NVSS,FIRST,WISH`')[2]. The keyword `epoch` sets the equinox of the input coordinates. '`Flux`' sets flux limits.

The second example of the e-mail task is the matching procedure. There are some additional keywords '`window box x=30″ y=10′` ', where 'V`box`' is the type of matching window (others are '`circle`' and '`ellipse`'), '`x`' and '`y`' are horizontal and vertical coordinate directions, respectively. Note that `x` and `y` are half the side lengths of the search `box`, the value following the `circle` keyword is its radius, and those following the `ellipse` keyword are the semi-major and semi-minor axes of the ellipse. For the moment no

[2] The full list of the CATS catalogs can be obtained from the CATS Web–page `http://cats.sao.ru/doc/CATS_list.html`

Table 1: *Example of an output returned upon a 'select' request. Columns are, respectively, the catalog name, the source name, the right ascension (hours, minutes and seconds of time) of the object, the error of RA (in time seconds) if available, otherwise 'n', the declination (degrees, minutes and seconds of arc), the error of declination (in arcseconds) if available, otherwise 'n', the frequency (MHz), the flux density (Jy), the error of flux density (Jy), the equinox ('J' means 'J2000.0', 'B' means 'B1950.0'). Note that the names are based on J2000 coords. here, but the user-specified output equinox was B1950.0, causing RA and DEC to be different from those in the J2000-based names.*

```
# TASK: select
#    default input  epoch: B1950.0
#    default output epoch: B1950.0
#    RA limits:   10:30:00.000 10:40:00.120
#    Dec limits:  00:10:00.001 00:12:29.999
#    GLon limits: 0 360
#    GLat limits: -90 90
#    Flux limits: 0.0005Jy 1000000Jy
#-------------------------------------------
# cat     name            RA          eRA      Dec        eDec freq   Flux(Jy)   eFl equi.
#-------------------------------------------------------------------------------------------
FIRST J103242.4-000331 10 30 08.668      n  +00 11 56.29     n 1400   0.01933 1.38e-04 B
NVSS  J103242-000332   10 30 08.7    0.054  +00 11 55.16  0.89 1400    0.0207    .0005 B
NVSS  J103343-000415   10 31 09.468  0.358  +00 11 14.17 12.24 1400    0.0040    .0006 B
NVSS  J103352-000433   10 31 18.72   0.281  +00 10 56.91  4.23 1400    0.0034    .0005 B
FIRST J103413.2-000432 10 31 39.430      n  +00 10 58.37     n 1400    0.0215 1.47e-04 B
FIRST J103413.2-000442 10 31 39.465      n  +00 10 48.12     n 1400   0.00735 1.46e-04 B
FIRST J103413.2-000453 10 31 39.502      n  +00 10 36.85     n 1400 9.9000e-04 1.46e-04 B
NVSS  J103413-000436   10 31 39.507  0.042  +00 10 54.34  0.73 1400    0.0317    .0005 B
FIRST J103748.6-000515 10 35 14.872      n  +00 10 20.65     n 1400   0.01031 1.48e-04 B
FIRST J103749.3-000522 10 35 15.577      n  +00 10 14.02     n 1400    0.0038 1.48e-04 B
NVSS  J103749-000521   10 35 15.601  0.052  +00 10 14.49  0.81 1400    0.0320    .0014 B
FIRST J103750.1-000525 10 35 16.372      n  +00 10 10.34     n 1400   0.01009 1.48e-04 B
FIRST J103846.6-000316 10 36 12.838      n  +00 12 21.62     n 1400   0.00132 1.38e-04 B
NVSS  J103749-000521   10 35 15.601  0.052  +00 10 14.49  0.81 1400    0.0320    .0014 B
FIRST J103750.1-000525 10 35 16.372      n  +00 10 10.34     n 1400   0.01009 1.48e-04 B
FIRST J103846.6-000316 10 36 12.838      n  +00 12 21.62     n 1400   0.00132 1.38e-04 B
NVSS  J103950-000324   10 37 16.805  0.598  +00 12 14.43  5.87 1400    0.0038    .0011 B
NVSS  J104008-000354   10 37 35.191  0.077  +00 11 45.81  1.27 1400    0.0134    .0005 B
FIRST J104008.9-000353 10 37 35.219      n  +00 11 45.97     n 1400   0.01254 1.47e-04 B
FIRST J104220.5-000409 10 39 46.783      n  +00 11 33.46     n 1400   0.00103 1.41e-04 B
#-----------------------------------------------------------------
#The catalogue identifications listed are related to the following references:
#-----------------------------------------------------------------
# FIRST  : 1997ApJ...475..479White+ FIRST survey catalogue at 1.4GHz
# NVSS   : 1998AJ....115.1693Condon+ 1996: NVSS survey catalog
```

Table 2: *Example of output data returned upon a 'match' request. The first 14 columns correspond to the columns of the Table 1. Other columns are, respectively, the distance from the search position (in arcsec), the position angle (in degrees from N through E) of the radius vector connecting the search center with the object.*

```
# TASK: match
# Search box 30 x 600 arcsec
# default input  epoch: J2000.0
# default output epoch: J2000.0
#
# cat    name            RA         eRA       Dec        eDec  freq Flux(Jy)  eFl equi.dist," pa,^
#-----------------------------------------------------------------------------------------------
#OBJECT: s1 02:02:00 +31:23:16 1950
WENSS WNB0202.5+3124   02 05 29.585      n  +31 39 07.7      n  325   0.077  .0036 J   453.9  282
NVSS  J020529+313912   02 05 29.738  0.071  +31 39 12.15  0.98 1400  0.0170  .0005 J   456.7  282
#@-----------------------------------------
#OBJECT: s2 02:23:10 34:03:00 1950
NVSS  J022526+341006   02 25 26.717  0.374  +34 10 06.63  3.85 1400  0.0037  .0005 J   664.4  125
NVSS  J022529+342450   02 25 29.186  0.412  +34 24 50.47   5.6 1400  0.0030  .0007 J   716.3   46
WENSS WNB0223.1+3408   02 26 10.154      n  +34 21 30.7      n  325   3.678  .0045 J   301.8    1
GB6   J0226+3421       02 26 10.2      0.5  +34 21 25        8 4850   1.628   .145 J   296.1    1
NVSS  J022610+342130   02 26 10.337  0.036  +34 21 30.31  0.56 1400  2.8949  .0005 J   301.4    0
NVSS  J022649+340740   02 26 49.391  0.349  +34 07 40.85   4.2 1400  0.0034  .0007 J   715.4  222
#@-----------------------------------------
#OBJECT: s3 21:26:33.9 -18:34:33.0 1950
NVSS  J212840-183008   21 28 40.07   0.272  -18 30 08.45  6.54 1400  0.0039  .0006 J   788.5  228
NVSS  J212840-181420   21 28 40.26   0.306  -18 14 20.93  3.08 1400  0.0048  .0005 J   722.6  306
NVSS  J212840-182926   21 28 40.26   0.537  -18 29 26.22  6.54 1400  0.0034  .0006 J     759  230
NVSS  J212841-181322   21 28 41.531  0.299  -18 13 22.25  5.09 1400  0.0049  .0006 J   744.6  310
NVSS  J212855-181737   21 28 55.425  0.035  -18 17 37.7   0.78 1400  0.1092  .0040 J   433.5  301
NVSS  J212859-181253   21 28 59.241  0.038  -18 12 53.21  0.65 1400  0.0462  .0018 J     600  328
NVSS  J212921-182122   21 29 21.414  0.032  -18 21 22.99  0.56 1400  1.4124  .0005 J     0.3  337
NVSS  J212945-182052   21 29 45.696  0.112  -18 20 52.35  1.61 1400  0.0089  .0005 J   346.9   85
NVSS  J212950-181500   21 29 50.726  0.387  -18 15 00.03  5.15 1400  0.0032  .0005 J   566.6   47
NVSS  J212952-182910   21 29 52.722  0.045  -18 29 10.27   0.7 1400  0.0372  .0015 J   645.2  136
#@-----------------------------------------
#The catalogue identifications listed are related to the following references:
#---------------------------------------------------------------
# GB6    : 1996ApJS..103..427Gregory+ The GB6 catalog;;
# NVSS   : 1998AJ....115.1693Condon+ 1996: NVSS survey catalog (updated! - v.40, Jul-02);
# WENSS  : 1997A&AS..124..259Rengelink+ The Westerbork Northern Sky Survey (WENSS).
```

position angle (PA) of the search ellipse may be given, and PA = 0° is assumed (i.e. semi-major axis along the N–S direction). The keyword '`sources:`' shows that the following records separated by a newline code are source coordinates to be used for the matching procedure. Each record contains the name of an object, its equatorial coordinates (R.A. and Dec.) and the corresponding equinox.

Keywords in the batch request may be separated by a space, a tabulation or newline character.

The full information about the keywords and formats can be requested with an empty e-mail to the address `cats@sao.ru` (no subject required).

Results of these two sample requests are shown in Tables 1 and 2.

The main catalogs

The major source of radio catalogs of CATS is the collection of one of us (Andernach 1990, 1999), who has spent large efforts to recover older source lists not previously available in electronic form, using a scanner and optical character recognition software. This collection is complemented in several ways: contributions from authors, astro-ph preprints, tables from electronic journals and the CDS catalog archive, as well as occasional manual retyping of the original catalog. About 70 catalogs have been typed and/or corrected manually at SAO RAS by S.Trushkin. The largest catalogs (e.g. NVSS, FIRST, SDSS, etc.) were copied from Web-sites of the catalog authors.

CATS is mainly a radio-astronomical database. All major catalogs incorporated into CATS are shown in Tables 3 and 4 (adapted and updated from Table 1 of Andernach 1999).

Table 3: *Major radio astronomical catalogs of the CATS database*

Freq. (MHz)	Name	Year of publ.	RA (h) or l (d)	Dec (°) or b (d)	HalfPower BeamWidth (arcmin)	S_{min} (mJy)	Number of objects
10-25	UTR-2	78-95	0-24	>-13	25..60	10000	1754
38	8C	90/95	0-24	>+60	4.5	1000	5859
74	VLSS	2004	0-24	> -30	1.3	350	32521
80	CUL1	73	0-24	-48,+35	3.7	2000	999
80	CUL2	75	0-24	-48,+35	3.7	2000	1748
82	IPS	87	0-24	-10,+83	27x350	500	1789
151	6CI	85	0-24	<+80	4.5	200	1761
151	6CII	88	8.5-17.5	+30,+51	4.5	200	8278
151	6CIII	90	5.5-18.3	+48,+68	4.5	200	8749
151	6CIV	91	0-24	+67,+82	4.5	200	5421
151	6CVa	93	1.6- 6.2	+48,+68	4.5	300	2229
151	6CVb	93	17.3-20.4	+48,+68	4.5	300	1229
151	6CVI	93	22.6- 9.1	+30,+51	4.5	300	6752
151	7CI	90	(10.5+41)	(6.5+45)	1.2	80	4723
151	7CII	95	15-19	+54,+76	1.2	100	2702
151	7CIII	96	9-16	+20,+35	1.2	150	5526
160	CUL3	77	0-24	-48,+35	1.9	1200	2045
178	4C	65	0-24	-7,+80	15x7.5	2000	4844
232	MIYUN	96	0-24	+30,+90	3.8	100	34426
325	WENSS	98	0-24	+30,+90	0.9	18	229420
327	WSRT	91	5 fields	(+40,+72)	1.0	3	4157
352	WISH	2002	0-24	-25,-9	0.9	18	90357
365	TXS	96	0-24	-35.5,+71.5	.1	250	66841
408	MRC	81/91	0-24	-85,+18.5	3	700	12141
408	B2	70-73	0-24	+24,+40	3 x10	250	9929
408	B3	85	0-24	+37,+47	3 x 5	100	13354
608	WSRT	91	sev.fields	(40, 72)	0.5	3	1693
611	NAIC	75	22-13	-3,+19	12.6	350	3122
843	SUMSS	99	0-24	< -30	0.72	6	178975
1400	GB	72	7-16	+46,+52	10x11	90	1086
1400	GB2	78	7-17	+32,+40	10x11	90	2022
1400	WB92	92	0-24	-5,+82	10x11	150	31524

Freq. (MHz)	Name	Year of publ.	RA (h) or l (d)	Dec (°) or b (d)	HalfPower BeamWidth (arcmin)	S_{min} (mJy)	Number of objects
1400	NVSS	98	0-24	-40,+90	0.9	2.0	1810668
1400	FIRST	98	7.3,17.4	22.2,57.6	0.1	1.0	811117
		98	21.3,3.3	-11.5,+1.6			
1400	PDF	98	1.1 -1.3	-46,-45	0.1-0.2	0.1	1079
1500	VLANEP	94	17.4,18.5	63.6,70.4	0.25	0.5	2436
2700	PKS	(90)	0-24	-90,+27	8	50	8264
3900	Z	89	0-24	0,+14	1.2x52	50	8503
3900	RC	91/93	0-24	4.5,5.5	1.2x52	4	1189
3900	Z2	95	0-24	0,+14	1.2x52	40	2943
4850	MG1-4	86-91	var.	0,+39	3.5	50	24180
4850	87GB	91	0-24	0,+75	3.5	25	54579
4850	GB6	96	0-24	0,+75	3.5	18	75162
4850	PMNM	94	0-24	-88,-37	4.9	25	15045
4850	PMN-S	94	0-24	-87.5,-37	4.2	20	23277
4850	PMN-T	94	0-24	-29,-9.5	4.2	42	13363
4850	PMN-E	95	0-24	-9.5,+10	4.2	42	11774
4850	PMN-Z	96	0-24	-37,-29	4.2	70	2400
31	NEK	88	$350 < l < 250$	$\|b\| < 2.5$	13x 11	4000	703
151	7C(G)	98	$80 < l < 180$	$\|b\| < 5.5$	1.2	100	6262
327	WSRTGP	96	$43 < l < 91$	$\|b\| < 1.6$	1.0	10	3984
1400	GPSR	90	$20 < l < 120$	$\|b\| < 0.8$	0.08	25	1992
1408	RRF	90	$357 < l < 95.5$	$\|b\| < 4.0$	9.4	98	884
1420	RRF	98	$95.5 < l < 240$	$-4 < b < 5$	9.4	80	1830
1400	GPSR	92	$350 < l < 40$	$\|b\| < 1.8$	0.08	25	1457
2700	F3R	90	$357 < l < 240$	$\|b\| < 5$	4.3	40	6483
4875	ADP79	79	$357 < l < 60$	$\|b\| < 1$	2.6	120	1186
5000	GT	86	$40 < l < 220$	$\|b\| < 2$	2.8	70	1274
5000	GPSR	94	$350 < l < 40$	$\|b\| < 0.4$	0.07	3	1272
5000	GPSR	79	$190 < l < 40$	$\|b\| < 2$	4.1	260	915

Names of catalogs contained in CATS with corresponding references are presented in **Appendix**.

CATS also contains observational and combined catalogs of Galactic supernova remnants (e.g., Trushkin et al. 1987; Trushkin 1996), secondary tables with objects selected by spectral index (Chambers et al. 1996; Röttgering et al. 1994; De Breuck et al. 2000), variability or AGN properties (Kovalev et al. 1999, 2000). Also the database includes source catalogs obtained from cross-identifications performed within CATS (IRAS–TXS: Trushkin & Verkhodanov (1995) and Verkhodanov & Trushkin (2000); UTR_ID: Verkhodanov et al. (2000c, 2003); WMAP: Trushkin (2004)).

Examples of some typical tasks

• *Extraction of a sample of steep-spectrum radio sources from the FIRST catalog.*
To execute this task, one may use the FIRST (1400 MHz) and Texas (365 MHz) catalogs selection in a given zone. The FIRST and Texas catalogs have a flux density limit of about 1 and 150 mJy, respectively. A cross-matching of objects in any sky zone where these two catalogs overlap will return sources with the required properties. Thus, we prepare 2 requests: (1) select all objects from a given zone in the FIRST catalog with the 'select'–function, (2) using the list of FIRST sources obtained in (1) we cross-identify selected objects with the Texas data with the 'match'–function. The resulting list can be used to finish the required selection in the given zone.

• *Identification of objects with optical catalogs in CATS.*
Open the CATS web page with optical catalogs, and provide the input list of objects. Alternatively, select '`catalogs o`' in your e-mail request, provide a list of objects of interest, and send the request.

Summary

CATS provides a simple and convenient access to astrophysical data and complements the data available from other services, most notably for radio continuum flux densities, for which it is the largest database in existence. Operation with the database permit astronomers to search for peculiar objects and study physical processes in sources of cosmic radiation.

Until October 2004, we registered over 28000 requests for the 'select' or 'match' procedures, which

Table 4: *Some catalogs of other wavelength ranges in the CATS*

λ	PGC	Publ	RA	Dec	Number
opt	PGC	89	0-24	-90,+90	73197
opt	MCG	75	0-24	-33.5,+90	31886
opt	MSL	85	0-24	-90,+90	181603
opt	SDSS DR2	2004	several fields		Gals: 216906 QSOs: 22033
ir	IRASPSC	87	0-24	-90,+90	245889
ir	IRASFSC	89	0-24	$\|b\| > 10$	235935
ir	IRASSSC	89	0-24	-90,+90	43886
ir	2MASS	2000	0-24	-90,+90	470992970
Xray	ROSAT	95	0-24	-90,+90	74301
mix	QSO HB2	93	0-24	-84,+86	7315
mix	VERON+11	93	0-24	-83,+85	48921

are the most popular. The most popular catalogs for FTP-copying over the last five years are QSO by Hewitt & Burbidge (20 times), PGC (19 times), and NVSS (18 times). CATS processes daily up to 1000 HTTP–requests for information concerning the catalog descriptions.

CATS is being expanded continuously and presently comprises more than 400 catalogs including all the RATAN–600 catalogs. The database in its present form occupies about 60 Gb of disk space.

Acknowledgements. The authors are thankful to Alexander Kopylov and Grigorij Tsarevsky for testing CATS procedures and catalogs and suggesting some improvements, and to N.F. Voikhanskaya for useful remarks. This work is supported by the grants 96–07–89075, 02–07–90038 of Russian Foundation of Basic Researches.

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Appendix

UTR-2	Braude et al. (1978, 1979, 1981, 1985, 1994, 2002);
8C	Hales et al. (1995);
VLSS	Lane et al., (2004);
CUL1,2,3	Slee et al. (1995);
IPS	Purvis et al. (1987),
6C	Baldwin et al. (1985), Hales et al. (1988, 1990, 1991, 1993a,b, 1995);
7C	McGilchrist & Riley (1990), Visser et al. (1995), Lacy et al. (1995), Waldram et al. (1996), Pooley et al. (1998), Riley et al. (1999a,b);
4C	Gower et al. (1967);
MIYUN	Zhang et al. (1997);
WENSS	Rengelink et al. (1997);
WSRT	Valentijn et al. (1977), Goss et al. (1977, 1980), Wouterloot & Dekker (1979), Habing et al. (1982), Isaacman (1981), Matthews & Spoelstra (1983), Oort & Windhorst (1985), Wieringa (1991), Roland et al. (1990), Taylor et al. (1996);
WISH	De Breuck et al. (2002);
TXS	Douglas et al. (1996);
MRC	Large et al. (1991);
B2	Colla et al. (1970);
B3	Ficarra et al. (1985);
NAIC	Durdin et al. (1975), Lawrence et al. (1986);
SUMSS	Bock et al. (1999);
GB	Maslowski (1972), Machalski (1978), Rys & Machalski (1987);
WB92	White & Becker (1992);
NVSS	Condon et al. (1998);
FIRST	White et al. (1997)
PDF	Hopkins (1998), Hopkins et al. (1998);
VLANEP	Kollgaard et al. (1994);
PKS	Wright & Otrupcek (1990), Otrupcek & Wright (1991);
Z	Amirkhanyan et al. (1989);
RC	Parijskij et al. (1991, 1992);
Z2	Larionov et al. (1991);
MG1-4	Bennett et al. (1986), Langston et al. (1990), Griffith et al. (1990, 1991);
87GB	Gregory & Condon (1991);
GB6	Gregory et al. (1996);
PMN	Gregory et al. (1994), Wright et al. (1996);
NEK	Kassim (1988);
7C(G)	Vessey & Green (1998);
WSRTGP	Taylor et al. (1996);
GPSR	Becker et al. (1994), Garwood et al. (1988), Helfand et al. (1992), Zoonematkermani et al. (1990);
RRF	Reich et al. (1990);
F3R	Fürst et al. (1990);
ADP79	Altenhoff et al. (1979)
GT	Gregory & Taylor (1986);
PGC	Paturel et al. (1989);
MCG	Kogoshvili (1982);
MSL	Dixon (1970, 1980), Dixon et al. (1981), with corrections from Andernach (1989) and later updates;
SDSS DR2	Schneider et al. (2001, QSOs list), Abazajian et al. (2004);
IRASPSC	Beichman et al. (1988): IRAS Point Source Catalog;
IRASFSC	Beichman et al. (1988): IRAS Faint Source Catalog;
IRASSSC	Beichman et al. (1988): IRAS Serendipitous Survey Catalog;
2MASS	Cutri et al. (2002);
ROSAT	White et al. (2000);
QSO HB	Hewitt & Burbidge (1993);
VERON+11	Véron-Cetty and Véron (2003).